CHAPTER 1

Some Basic Concepts of Chemistry

CHAPTER ANALYSIS

	IIT JEE 2010		IIT JEE 2011		IIT JEE 2012		JEE Advanced 2013		JEE Advanced 2014		JEE Advanced 2015		JEE Advanced 2016		JEE Advanced 2017	
	Paper		Paper		Paper		Paper		Paper		Paper		Paper		Paper	
Topic	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Importance of Chemistry																
Nature of Matter																
Properties of Matter and their Measurement	1								1							
Uncertainty in Measurement																
Laws of Chemical Combinations																
Dalton Atomic Theory																
Atomic and Molecular Masses																
Mole Concept and Molar Masses			1	1												
Percentage Composition			1		1											
Stoichiometry and Stoichiometric Calculations																

QUESTIONS

1. The normality of 0.3 M phosphorus acid (H_3PO_3) is

(A) 0.1 (B) 0.9

(C) 0.3 (D) 0.6

(IIT JEE 1999)

2. At 100 °C and 1 atm if the density of the liquid water is 1.0 g cm^{-3} and that of water vapour is 0.0006 g cm^{-3}, then the volume occupied by water molecules in 1 litre of steam at this temperature is

(A) 6 cm^3 (B) 60 cm^3

(C) 0.6 cm^3 (D) 0.06 cm^3

(IIT JEE 2000)

3. An aqueous solution of 6.3 g oxalic acid dehydrate is made up to 250 ml > the volume of 0.1 N NaOH required to completely neutralise 10 ml of this solution is

(A) 40 ml (B) 20 ml

(C) 10 ml (D) 4 ml

(IIT JEE 2001)

4. How many moles of an electron weighs one kilogram?

(A) 6.023×10^{23}

(B) $\frac{1}{9.108} \times 10^{31}$

(C) $\frac{6.023}{9.108} \times 10^{54}$

(D) $\frac{1}{9.108 \times 6.023} \times 10^{8}$

(IIT JEE Screening 2002)

5. Write balanced equations for the reactions of the following compounds with water:

(1) Al_4C_3 (2) CaNCN (3) BF_3

(4) NCl_3 (5) XeF_4

(IIT JEE Main 2002)

6. Which of the following has the maximum number of atoms?

(A) 24 g of C (12) (B) 56 g of Fe (56)

(C) 27 g of Al (27) (D) 108 g of Ag (108)

(IIT JEE Screening 2003)

7. Mixture X = 0.02 mol of $[Co(NH_3)_5SO_4]Br$ and 0.02 mol of $[Co(NH_3)_5Br]SO_4$ was prepared in 2 L of solution.

1 L of mixture X + excess $AgNO_3 \rightarrow Y$

1 L of mixture X + excess $BaCl_2 \rightarrow Z$

Number of moles of Y and Z are

(A) 0.01, 0.01 (B) 0.02, 0.01

(C) 0.01, 0.02 (D) 0.02, 0.02

(IIT JEE Screening 2003)

8. Calculate the molarity of water if its density is 1000 kg/m^3.

(IIT JEE Main 2003)

9. AlF_3 is insoluble in anhydrous HF but when little KF is added to the mixture it becomes soluble. On addition of BF_3, AlF_3 is precipitated out. Write the balanced chemical equations to depict these changes.

(IIT JEE Main 2004)

10. Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5%, 90% and 5%, respectively, the atomic mass of Fe is

(A) 55.85 (B) 55.95

(C) 55.75 (D) 56.05

(IIT JEE 2009 Paper-1)

11. Among the following, the intensive property is (properties are)

(A) Molar conductivity

(B) Electromotive force

(C) Resistance

(D) Heat capacity

(IIT JEE 2010 Paper-1)

12. Dissolving 120 g of urea (mol. wt. 60) in 1000 g of water gave a solution of density 1.15 g/mL. The molarity of the solution is

(A) 1.78 M (B) 2.00 M

(C) 2.05 M (D) 2.22 M

(IIT JEE 2011 Paper-1)

13. A decapeptide (mol. wt. 796) on complete hydrolysis gives glycine (mol. wt. 75), alanine and phenylalanine. Glycine contributes 47.0% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is _____.

(IIT JEE 2011 Paper-1)

14. The volume (in mL) of 0.1 M $AgNO_3$ required for complete precipitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is close to _____.

(IIT JEE 2011 Paper-2)

15. 29.2% (w/w) HCl stock solution has density of 1.25 g mL^{-1}. The molecular weight of HCl is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is _____.

(IIT JEE 2012 Paper-1)

16. If the value of Avogadro number is 6.023×10^{23} mol^{-1} and the value of Boltzmann constant is 1.380×10^{-23} J K^{-1}, then the number of significant digits in the calculated value of the universal gas constant is _____.

(JEE Advanced 2014 Paper-1)

ANSWER KEY

1. (D) **2.** (C) **3.** (A) **4.** (D)

5. (1) $Al_4C_3 + 6H_2O \rightarrow 4Al(OH)_3 + 3CH_4$;

(2) $CaCN_2 + 5H_2O \rightarrow CaCO_3 + 2NH_4OH$;

(3) $BF_3 + 3H_2O \rightarrow B(OH)_3 + 3HF$;

(4) $NCl_3 + 4H_2O \rightarrow NH_4OH + 3HOCl$;

(5) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + \frac{3}{2}O_2$

6. (A) **7.** (A) **8.** 55.56 mol/L **9.** $K_3AlF_6 + 3BF_3 \rightarrow AlF_3 + 3KBF_4$ **10.** (B) **11.** (A), (B)

12. (C) **13.** 6 **14.** 6 **15.** 8 mL **16.** 4

ANSWERS WITH EXPLANATIONS

1. Topic: Mole Concept and Molar Masses

We know that

Normality = $M \times$ basicity

Basicity of phosphorus acid is 2. That is, phosphorus acid has two replaceable hydrogen atoms.

Therefore, Normality = $0.3 \times 2 = 0.6$

Answer (D)

2. Topic: Mole Concept and Molar Masses

Let volume of H_2O = 1 L; then mass = 1000 g

$$\text{So, volume of 1000 g steam} = \frac{1000}{0.0006}\ \text{cm}^3$$

Volume of molecules in 1000 g of steam is

$$= 1000 \times \frac{0.0006}{1000} \times 1000 = 0.60\ \text{cm}^3$$

Answer (C)

3. Topic: Mole Concept and Molar Masses

Oxalic acid dehydrate is $C_2H_2O_4 \cdot 2H_2O$

$$\text{Equivalent mass of oxalic acid} = \frac{126}{2} = 63$$

$$\text{Therefore, Normality of oxalic acid} = \frac{6.3}{63} \times \frac{1000}{250} = 0.4$$

Now from, $N_1V_1 = N_2V_2$

Where, N_1 is normality of oxalic acid, V_1 is volume of oxalic acid, N_2 is normality of NaOH and V_2 is volume of NaOH. Substituting all values, we get

$0.1 \times V_1 = 0.4 \times 10$

$$V_1 = \frac{0.4 \times 10}{0.1} = 40\ \text{mL}$$

Answer (A)

4. Topic: Mole Concept and Molar Masses

We know that the mass of electron is 9.108×10^{-31} kg. Therefore, mass of 1 mole of electrons is

$9.108 \times 10^{-31} \times 6.023 \times 10^{23}$ kg.

Thus, the number of moles of electrons in 1 kg is

$$\frac{1}{9.108 \times 10^{-31} \times 6.023 \times 10^{23}} = \frac{10^8}{9.108 \times 6.023}$$

Answer (D)

5. Topic: Stoichiometry and Stoichiometric Calculations

(1) $Al_4C_3 + 6H_2O \rightarrow 4Al(OH)_3 + 3CH_4$

(2) $CaCN_2 + 5H_2O \rightarrow CaCO_3 + 2NH_4OH$

(3) $BF_3 + 3H_2O \rightarrow B(OH)_3 + 3HF$

(4) $NCl_3 + 4H_2O \rightarrow NH_4OH + 3HOCl$

(5) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + \frac{3}{2}O_2$

6. Topic: Mole Concept and Molar Masses

24 g carbon is equal to 2 moles of carbon, so it contains $2 \times 6.023 \times 10^{23}$ atoms. 56 g of Fe, 27 g of Al and 108 g of Ag are equivalent to one mole and hence the number of atoms is 6.023×10^{23}.

Answer (A)

7. Topic: Mole Concept and Molar Masses

In concentration of the complexes in one litre of the solution is

$[Co(NH_3)_5SO_4]Br = 0.01$ mol

$[Co(NH_3)_5Br]SO_4 = 0.01$ mol

Therefore, 0.01 mol of Br ion from X in 1 L of mixture will react with excess $AgNO_3$ to form 0.01 mol of AgBr.

Similarly, 0.01 mol of SO_4 ion from Y in 1 L of mixture will react with excess $BaCl_2$ to form 0.01 mol of $BaSO_4$.

$$\underset{\text{Excess}}{Ag^+} + \underset{0.01\ \text{mole}}{Br^-} \rightarrow \underset{0.01\ \text{mole}}{AgBr}$$

$$\underset{\text{Excess}}{Ba^{2+}} + \underset{0.01\ \text{mole}}{SO_4^{2-}} \rightarrow \underset{0.01\ \text{mole}}{BaSO_4}$$

Answer (A)

8. Topic: Mole Concept and Molar Masses

Molarity is defined as the number of moles of solute present/ volume of solution in litres.

It is given that the density is 1000 kg m^{-3}; therefore,

1 L of water = 1 kg = 1000 g.

Therefore, numbers of moles of solute present

$$= \frac{1000\ (\text{given mass})}{18\ (\text{molecular mass})} = 55.56\ \text{mol of}\ H_2O$$

Hence, molarity is 55.56 mol per litre.

Answer (55.56 mol/L)

9. Topic: Stoichiometry and Stoichiometric Calculations

Anhydrous HF is stabilised by hydrogen bonding and hence the extent of dissociation is less. Hence, AlF_3 when added to it is insoluble. On addition of KF, AlF_3 dissolves in HF with the formation of complex $[AlF_6]^{3-}$

$$3KF + AlF_3 \rightarrow K_3AlF_6$$

On addition of BF_3, AlF_3 is precipitated out because BF_3 being more acidic can replace AlF_3 from the complex.

$$K_3AlF_6 + 3BF_3 \rightarrow AlF_3 + 3KBF_4$$

10. Topic: Atomic and Molecular Masses

The atomic mass of Fe based on relative abundances of isotopes is

$$54\times\frac{5}{100}+56\times\frac{90}{100}+57\times\frac{5}{100}=55.95$$

Answer (B)

11. Topic: Properties of Matter and their Measurement

Molar conductivity and emf are mass/size independent properties, hence intensive. Resistance and heat capacity are mass-dependent properties, hence extensive.

Answer (A), (B)

12. Topic: Mole Concept and Molar Masses

The mass of the solution of water and urea

$1000 + 12 = 1012$ g

$$\text{Volume of solution} - \frac{\text{Mass of solution}}{\text{Density of solution}}$$

$$=\frac{1012}{1.15}=973.91\ \text{g/mL}$$

$$\text{Molarity}=\frac{\text{Number of moles}}{\text{Volume of solution in litres}}$$

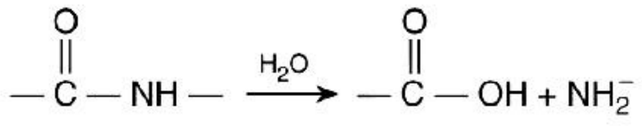
$$\text{Number of moles}=\frac{120}{60}=2$$

$$\text{Therefore, Molarity}=\frac{2}{0.974}=2.05\ \text{M}$$

Answer (C)

13. Topic: Percentage Composition

The hydrolysis reaction of peptide linkage is



Let n glycine units be present in the compound, then the total weight of the product will be

$796 + 9 \times 18 = 958$ (since there are 9 water molecules)

Percent weight of glycine in the given weight of product

$$\frac{75n}{958}\times100=47\%$$

Therefore,

$$n=47\times\frac{958}{75}\times100=6$$

Answer (6)

14. Topic: Mole Concept and Molar Masses

The reaction taking place is

$$2AgNO_3+[Cr(H_2O)_5Cl]Cl_2$$

$$\downarrow$$

$$2AgCl+[Cr(H_2O)_5Cl](NO_3)_2$$

Using molarity equation

$$(M\times n\times V)_{AgNO_3}=(M\times n\times V)_{[Cr(H_2O)_5Cl]Cl_2}$$

$$0.1\times1\times V=0.01\times2\times30\Rightarrow V=6$$

Answer (6)

15. Topic: Percentage Composition

Given that density of solution = 1.25 g mL^{-1}.

29.2% HCl means 29.2 g of HCl in 100 g of the solution

$$\text{Density of the solution}=\frac{\text{Mass of the solution}}{\text{Volume of solution}}$$

$$\Rightarrow\qquad V=\frac{100}{1.25}\text{mL}$$

Now,

Molarity of the solution

$$=\frac{\text{Number of moles of HCl}}{\text{Volume of solution}}\times1000$$

$$=\frac{29.2/36.5}{100/1.25}\times1000=10\,\text{M}$$

Using molarity equation, $M_1V_1=M_2V_2$, we get

$$10\times V=0.4\times200\Rightarrow V=8\ \text{mL}$$

Answer (8)

16. Topic: Properties of Matter and their Measurement

Since, we know that

$R = N_A \times k_B$

$= 6.023 \times 10^{23} \times 1.380 \times 10^{-23}$

$= 8.312$ (four significant figures)

Answer (4)